Charge dependent correlations relative to the 4th-harmonic event plane in Au+Au collisions at 27 and 39 GeV at RHIC/STAR

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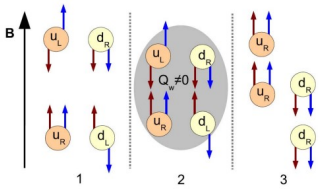
Abstract

In the chiral magnetic effect (CME) [1], an electric current is induced in the presence of a strong magnetic field and a chirality imbalance in the medium created in high-energy nuclear collisions. One corresponding observable for the charge separation across the reaction plane Ψ_{RP} is the charge dependent two-particle azimuthal correlator, $\gamma_{112} = < \cos(\phi_\alpha + \phi_\beta - 2\Psi_{RP}) >$. However, the γ_{112} contains both the CME signal and the flow background, complicating the interpretation of the data. In this poster, we investigate the background mechanism with a modified correlator, $\gamma_{224} = < \cos(2\phi_\alpha + 2\phi_\beta - 4\Psi_{RP}) >$. The γ_{224} only contains the background, and reflects the role played by the collective flow in the original γ_{112} correlator. We will present the STAR data of γ_{224} as a function of centrality measured in Au+Au collisions at 27 and 39 GeV. The results will be compared with those obtained by the ALICE experiment at a much higher collision energy, and will also be compared with model calculations. The physics implications will be discussed. [1]D. Kharzeev, Phys. Lett. B 633 (2006) 260.

Introduction

◊**Chiral Magnetic Effect (CME) -** Results from the strong magnetic field created in nuclear collisions and a local chirality imbalance; creates an electric current along the B field.

$$\vec{J} = \frac{e^2}{2\pi^2}\mu_5\vec{B}$$

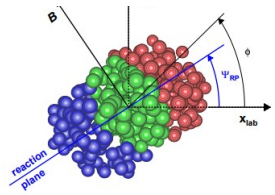


◊Fourier series of the charged particle azimuthal distribution of produced particles:

$$\frac{dN}{d\phi} = 1 + 2\,v_1\langle cos(\phi - \Psi)\rangle + 2v_2\langle cos(2(\phi - \Psi))\rangle + \ \ldots + 2a_1 sin(\phi - \Psi)$$

Directed flow — Elliptic flow

where:
$v_n = \langle \cos(n(\phi - \Psi))\rangle$
a is charge separation
n are flow harmonics



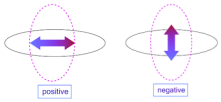
Motivation

◊The three-point correlator, γ_{112}, correlates a pair of particles with respect to the reaction plane Ψ_{RP} :

$$\gamma_{112} = \langle \cos(\phi_\alpha + \phi_\beta - 2\psi_{RP})\rangle$$
$$= [\langle v_{1,\alpha} v_{1,\beta}\rangle + B_{in}] - [\langle a_{1,\alpha} a_{a,\beta}\rangle + B_{out}]$$

where: α is the sign of electric charge.

Directed flow fluctuations relative to the elliptic flow plane

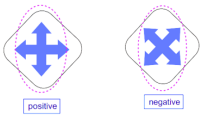


This correlation with respect to the second harmonic plane contains CME charge separation signal as well as flow-related background.

◊For the new correlator, γ_{224}, all angles have been doubled:

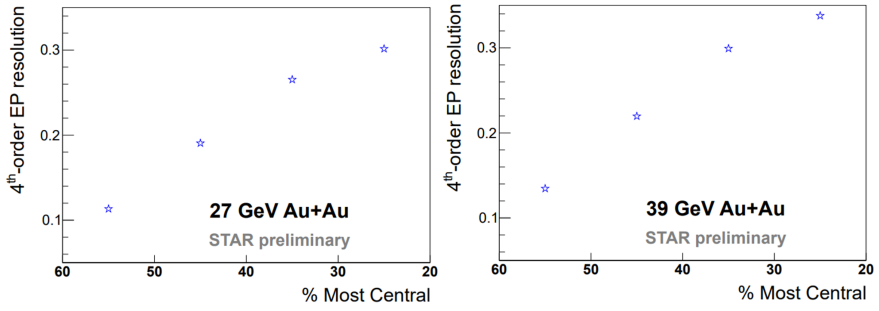
$$\gamma_{224} = \langle \cos(2\phi_\alpha + 2\phi_\beta - 4\psi_{RP})\rangle$$

Elliptic flow fluctuations relative to the quadrangular flow plane

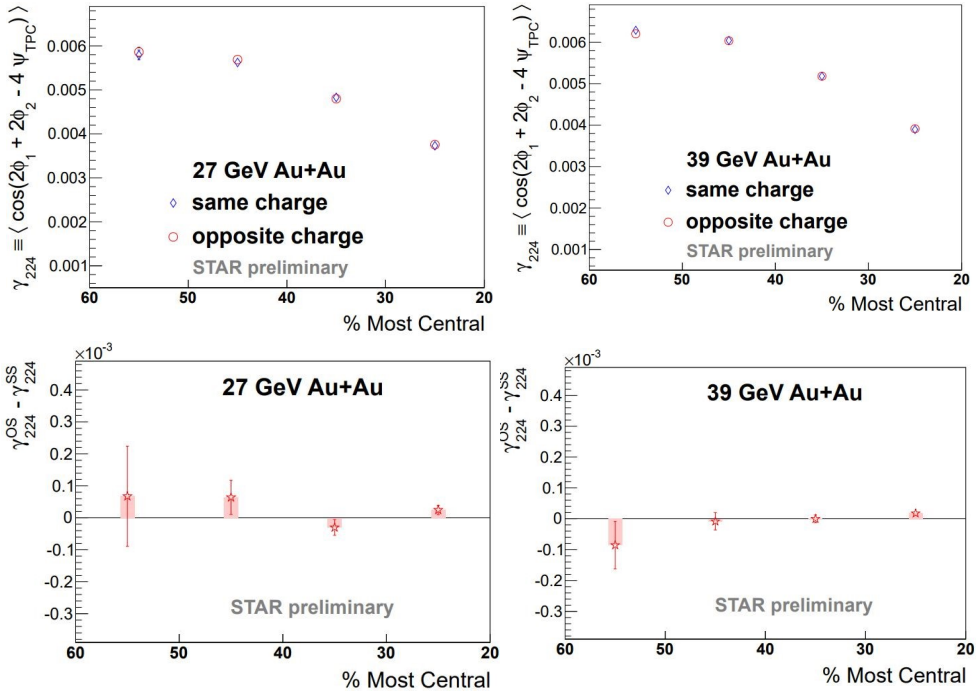


Correlations measured with respect to the fourth harmonic plane should not contain any CME contribution.

Event Plane (EP) Reconstruction



STAR Results



Summary

◊ The original γ_{112} correlator contains CME signal and background.

◊ We studied γ_{224} because it gives an insight to only flow-related background.

◊ Next would be to explore $\gamma_{123} = <\cos(\phi_\alpha + 2\phi_\beta - 3\Psi_{RP})>$, which would allow for a more accurate study of background vs CME signal.

Acknowledgements

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